Vulnerability of Climate Change on Biodiversity: A Geographical Study of Santhal Pargana Division, Jharkhand

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CONSENT OF THE SUPERVISOR

I hereby give my consent to supervise the candidate (BINDU MURMU) on the proposed synopsis **Vulnerability of Climate Change on Biodiversity: A Geographical Study of Santhal Pargana Division, Jharkhand** leading to a Ph.D degree of the University. I further certify that the synopsis referred to above is to the best of my knowledge and the information has not been published and submitted elsewhere for the award of any diploma or degree.

Date:

Place: Ranchi

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Vulnerability of Climate Change on Biodiversity: A Geographical Study of Santhal Pargana Division, Jharkhand

1. Brief Introduction of the research topic

Climate has always been evolving and vibrant in nature. In contemporary decades since the Industrial Revolution in 1900s, the dynamism in Climate have challenged the capacity of many species and communities to survive. The complexity of climate structure and its function have incorporated the interplay of biotic zone of biosphere and abiotic zone of lithosphere, hydrosphere and atmosphere. The IPCC report of 5th assessment reported the threats of climate change on the intensity, magnitude and timing of change as vulnerable regions of low coastal areas, nations built on islands and developing countries are under the most risk(IPCC, 2014). According to the United Nation Framework Convention on Climate Change(UNFCCC), Climate Change is the change of Climate characterized directly or indirectly to human activity that modifies the composition of the atmosphere besides variability of natural climate observed over comparable time periods(United Nations,1972). The UNFCCC makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate attributable to natural causes.

Climate Change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. The temperature changes globally of 5° C have followed 50-90% species of mass extinctions in the Earth's history(Hansen et.al 2006; McKeon and Gardner, 2009) proceeding Climate Change as one of the primary drivers of Biodiversity Loss. Accordingly Climate Change depends on Biodiversity as part of the Solution. Thus the two are interlinked in various aspects. Irrespective of its cause, through the years, the sensitivity of natural and biotic system has been negatively impacted. On a Global scale, hydrological system has been adjusted by varying precipitation patterns affecting quality and quantity of water resources. Thereby affecting the reproductive behavior of any individual species as the phenomenon of seed dispersal, pollination and fertilization are all correlated with the weather patterns(Anonymous,2009,(NBRD)).

Santhal Pargana is one of the physiographic divisions of Jharkhand State based on the geomorphic parameters. The Santhal Pargana uplands mainly the rugged and dissected plateau region presents wavy terrain with average relief of about 400-650m. Marking the districts of Sahebganj, Pakur, Godda, Dumka, Jamtara and Deoghar, the region is mainly composed of basaltic rocks with long chain of hills running from west to east. The Rajmahal hills primarily in the form of intra-trappean beds form a plateau(150-200m) above mean sea level in the eastern part of the state.

The compatible and sustainable strategies for diminishing and handling the climate change risks are Adaptation and Mitigation. These consists of effective institutions and

governance, investments and innovations, Green technologies and infrastructure, sustainable behavioral and lifestyle choices(IPCC, 2014). The Governance of Climate Change encompasses Non-Governmental Organisations, Industry associations and Companies and layers of government structure as local, regional, national and International(Pinkse and Kolk,2012). India is situated at the tri-junction of the Afro-tropical, the Indo-Malayan and the Paleo-Arctic realms, which display significant biodiversity. Being one of the 17 identified megadiverse countries, it is home to 8.58% mammalian, 13.66% avian, 7.91% reptilian, 4.66% amphibian and 11.72% fishes. (Saha, 1998).

2. State-Of-The-Art

The total Geographical area of Santhal Pargana is 14360.17 square km. It lies between the coordinates of 23˚ 40' to 25˚ 18' North Latitude and between 86˚ 28' to 87˚57' East Longitude. The administrative headquarter is located at Dumka. Santhal Pargana is bounded by the States of Bihar in the North and West Benga to the East. Currently this administrative division comprises of 6 districts as Dumka, Deoghar, Godda, Jamtara, Sahebganj and Pakur.

Climate Change threatens the vulnerability of biodiversity communities with shifting weather patterns and related feedback loops that alters the ecological equilibrium to realign with the dynamic changes.

Table: Vulnerability Index for Districts of Santhal Pargana

Serial No.	District	Sensitivity	Exposure	Adaptive Capacity	Vulnerability Index{(Exposure Adoptive Capacity) *Sensitivity}
1.	Dumka	0.25	0.6	0.51	0.02
2	Deoghar	0.20	0.48	0.36	0.02
3	Godda	0.23	0.59	0.34	0.06
4	Jamtara	0.26	0.59	0.21	0.10
5	Sahebganj	0.25	0.65	0.21	0.11
6	Pakur	0.30	0.82	0.17	0.20

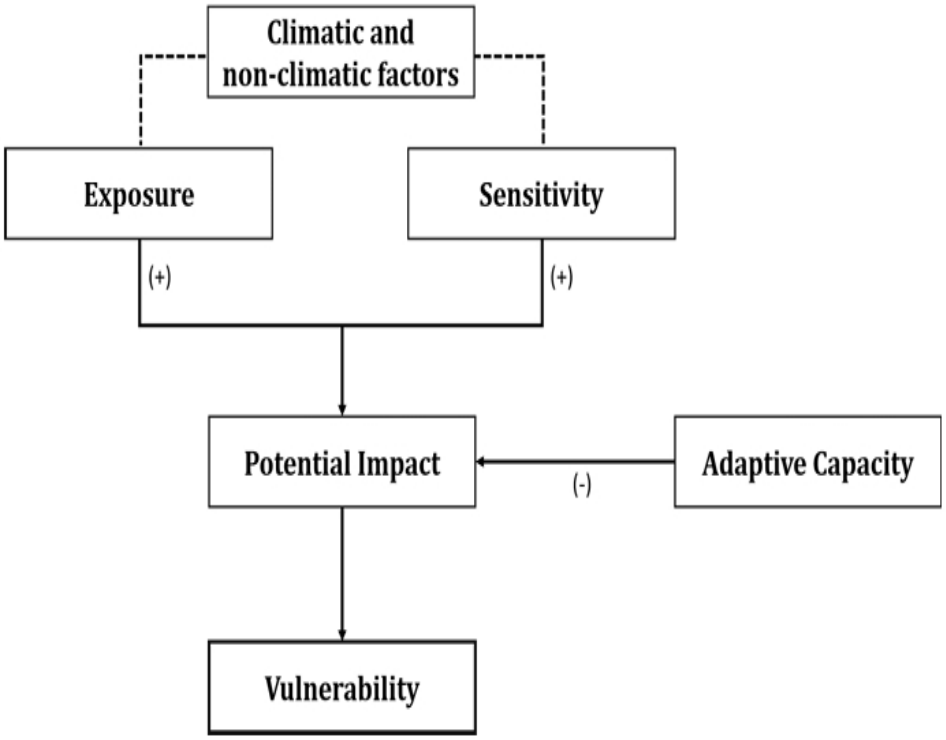
*(Scaling is done for -1 to +1 indicating low to high vulnerability)

Source: Jharkhand Action Plan for Climate Change,2014

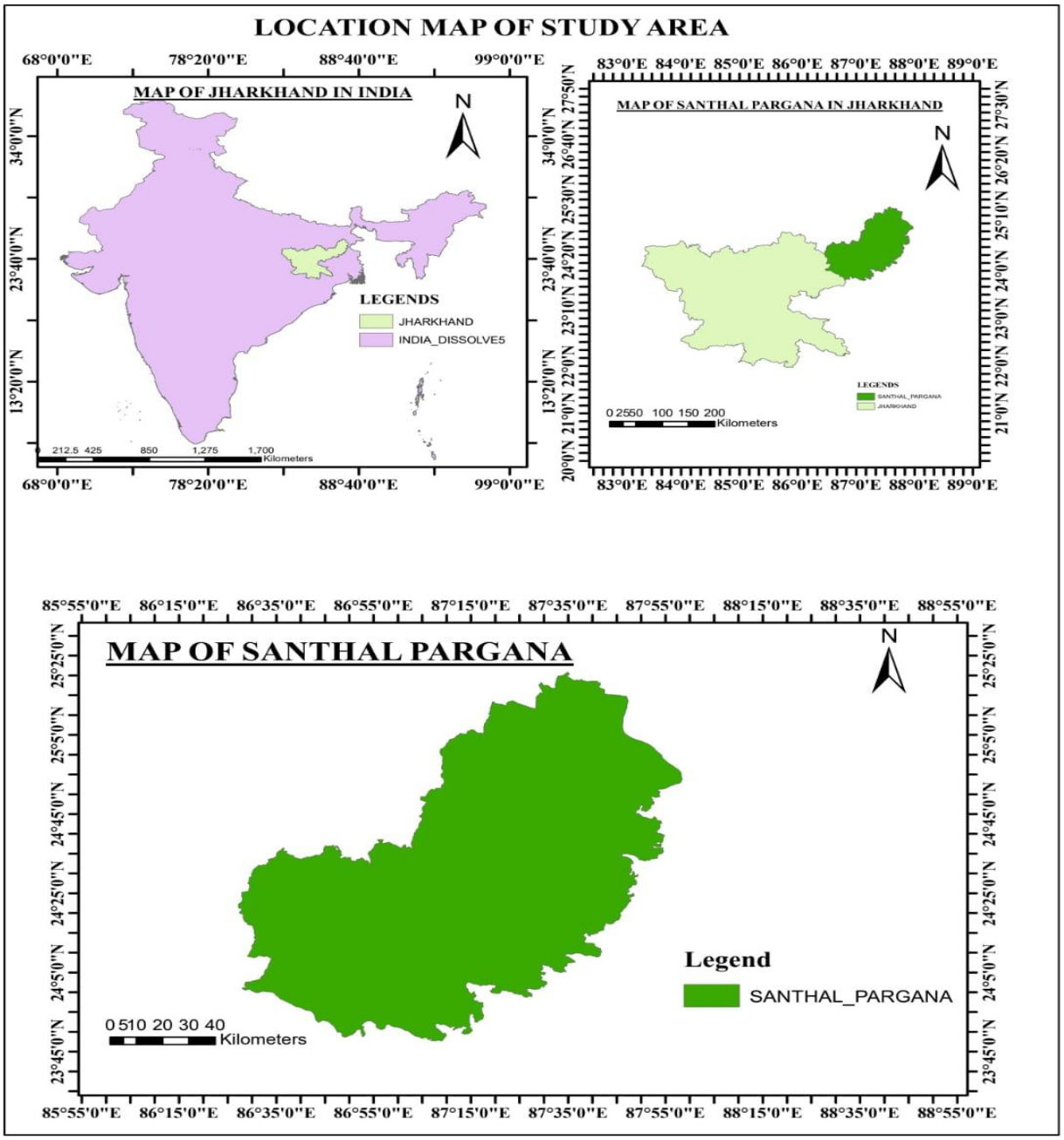
Through the data Pakur has the highest Vulnerability Index among the districts with 0.20 as the sensitivity, exposure and adoptive Capacity to the Climate Change is also highest with 0.30, 0.82 and 0.17 mainly due to economic backwardness and poor infrastructure in the region. Dumka and Deoghar have the same vulnerability index where Dumka has a better Adoptive Capacity as compared with other districts. Godda with 0.06 vulnerability index has better adoptive capacity in comparison to Jamtara and Sahebganj with 0.10 and 0.11 indices.

McCarthy et al. (2001) defined vulnerability to climate change as "a function of sensitivity and exposure of the system to climatic variability and change, and its adaptive capacity". IPCC (2001) defines vulnerability as "the degree to which a system is

susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity"
Exposure refers to the presence of people, livelihoods, species or ecosystems, environmental functions, services and resources , infrastructure, or economic, social or cultural assets in places and settings that could be adversely affected.
Sensitivity is the degree of an area or ecosystem affected by the climate related hazards.
While Exposure and Sensitivity is the area affected or at risk.
Adaptation is defined as "the adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderates harm or exploits beneficial opportunities" (McCarthy et al., 2001). Adaptive Capacity as recovering capacity with sensitivity and exposure the risk zone areas evaluates the biodiversity or systems vulnerability to Climate Change impacts.



Diagrammatic representation of conceptual framework of Vulnerability Assessment. The positive(+) and negative(-) signs shows the functional relationship of a component with variability.(Adapted from Füssel and Klein, 2006; IPCC, 2007).



Source: UDHG, Government of Jharkhand. Bhuvan: Indian Geo-Platform of ISRO

According to the S.S.Negi(1993), the term 'Biological Diversity' was first coined by the American Ecologist 'Thomas Lovejoy' in 1980. While 'Biodiversity' a compressed term of 'Biological Diversity' as coined in 1986 by American Entomologist Edward Osborne Wilson in a report for the first American forum on Biological Diversity coordinated by the National Research Council(NRC). The term Biological Diversity was replaced by 'Biodiversity' with respect to its inefficiency in communication. It has no standard definition with ambiguous terms. The Convention on Biological Diversity defines Biodiversity as the distinctiveness among the living organisms in the biosphere including marine, terrestrial and aquatic ecosystems and ecological complexes of which they have been part of; thus including species diversity between species and ecosystems.

According to the Hannad Reid(2004), the Climate Convention of United Nation Framework Convention on Climate Change(UNFCCC) and Convention on Biological Diversity formed in the Earth Summit, Rio de Janeiro , Brazil , 1992. They both aimed to stabilize the concentrations of Atmospheric Greenhouse gases initially by negotiating through global treaties as Kyoto Protocol(1997) and also suggesting practical measures for successive adaptation to the Climate Change. The Biodiversity Convention aimed for the conservation of Biological Diversity, the use of the components sustainably and the consumption of genetic resources through fair and equitable sharing.

As per **Government of India**, various initiatives have been undertaken by India as (a) for Nodal Ministry, the Ministry of Environment, Forest and Climate Change has been formed. (b) in 2006 National Environment Policy has been formed and(c) council of Prime Minister on Climate Change has been formed for matters concerning Climate Change. Under National Action Plan for Climate Change (NPCCC). Government of India has initiated various missions as National Solar Mission, National Plan for Conservation Of Aquatic Ecosystem(NPCA), National Mission on Sustainable Habitat, Biospheric Reserve, National Water Mission, National Mission for Sustaining the Himalayan Eco-system, National Mission for a Green India, National Mission for Sustainable Agriculture and Lastly on Strategic Knowledge for Climate Change.

Furthermore, **Biological Diversity Act 2002** has been initiated in three tier system with National level of National Biodiversity Authority (NBA), Board of State Biodiversity at the State level and the Committees of Biodiversity Management at the local level. According to Kohli Kanchi(2006), the India's Population particularly tribal and other traditional livelihood communities as farmers, pastoralist and hunter gatherers are dependent for food and survival on biological resources and biodiversity. Thus the loss of Biodiversity destabilizes ecosystem, reducing the productivity of ecosystems with the loss of nature's goods and services and its ability to combat the Climate Change.

According to **Mehta et al. (2010)** local people's awareness and understanding of climate change is a crucial necessity to improve coping strategies leading to better climate change adaptation). Increased awareness of people's views of different environmental changes may also lead to precise findings and feedback in framing policy for climate change adaptation approaches, whereas local communities' perceived knowledge may support scientific research (Reidlinger and Berkes 2001; Chaudhary and Bawa 2011).

According to Direct Foreign Development Investment (DFDI) Approach Paper,2011 the determinants of Climate Change can be sub categorized into built environment, institutional etc. from broader categories based upon the construction of Vulnerability Framework in the review of literature (Adoptive capacity, Sensitivity and Exposure). The Jharkhand Action Plan on Climate Change (JPCCC) for Jharkhand have used the methodology of exposure, sensitivity and Adoptive Capacity for Calculation of Vulnerability Index with indicators as Climate Change(Temperature Variance and Precipitation Variance) and Demographic composition for Exposure to the Risk of Vulnerability, Ecosystem and Agriculture for Calculation of Sensitivity and Socio-Economic Structure and Infrastructure for Adaptive Capacity(JPCCC, 2014).

Vulnerability Indices are the measures that assess the levels or susceptibility of a system and can be used to compare relative vulnerability of regions. Major purposes are identification of causal processes and the impacts of vulnerable systems, interlinkages and interdependency of system factors for its vulnerability outcomes, studied in scales from local, regional and global with distinct focus areas for policy formulation(Fussel and Klein 2006, Eakin and Luers 2006).
Exposure to climate Change and its resilience with the impacts shifts through temporal and spatial scales leading Vulnerability as a dynamic concept. The sensitivity, Exposure and Adaptive Capacity of a System in this study will be studies in context of biodiversity for assessments of Vulnerability to Climate Change.

3. Problems to be investigated

i. What are the Climatic Change assessment in Santhal Pargana in terms of temperature and precipitation variance?
ii. What are the geographic areas most vulnerable to biodiversity loss in Natural ecosystem and agro-bio ecosystem due to Climate Change?
iii. How do Geographic Variations in Climate Change influences regional biodiversity loss?
iv. What are the Socio-economic and Political Challenges in addressing Biodiversity loss due to Climatic Change?
v. How can Conservation Strategies be Adapted to account for the uncertainties associated with Climate Change?

4. Objective And Motivation

On Contemporary times, the far reaching effects of increasing global temperature and altered precipitation pattern have challenged the adaptive capacity of an ecosystem.

The Santhal Pargana have a unique ecological and cultural importance. With its indigenous plant species and rich wildlife a need for targeted conservation strategies could help in identifying at-risk species and predicts the shift in ecological patterns.

i. To determine the climatic change trends and patterns in the Study area of Santhal Pargana.
ii. To identify the geographic areas most vulnerable to biodiversity loss of natural ecosystem and agro-bio ecosystem due to Climate Change in Santhal Pargana.
iii. To compare the pattern formed by district wise biodiversity loss in natural and agro-bio ecosystem due to Climate Change.
iv. To identify the socio-economic and political challenges causing Biodiversity loss due to Climate Change in the Study Area of Santhal Pargana.
v. To provide the adaptation and mitigation strategies for sustainably conserving the biodiversity of Santhal Pargana.

5. Research Hypothesis

i. There is higher biodiversity loss in agro-bio ecosystem as compared to natural ecosystem due to Climate Change.
ii. There is no correlation between precipitation variation and Biodiversity loss.
iii. The plateau and Plain region of the Study area experiences high biodiversity loss than the hill region.
iv. Conservation Strategies are similar irrespective of the geographical variations.

6. Research Design And Methodology

The nature of the research is descriptive and analytical. Santhal Pargana being an administrative division of Jharkhand has been affected by Climate Change as it has become a global phenomenon. For identification of local climate change, the weather patterns of the Study Area would need to be studied through years by the meteorological parameters as temperature variability etc.

The required information and data can be acquired from Jharkhand Meteorological department, Government Reports, Local Surveys etc. Since the Study would be on the 6 districts of Santhal Pargana the determination of biodiversity rich regions can be studied by field survey on respective districts supplemented by the data of forest departments.

A. Tentative Chapterisation

Introduction

Chapter I: Geographical background of Santhal Pargana.

Chapter II: Assessment of Climate Change in Santhal Pargana.

Chapter III: District-wise Vulnerability of Biodiversity by Climate Change in natural ecosystem.

Chapter IV: District wise Vulnerability of Biodiversity by Climate Change in Agro-Bio ecosystem.

Chapter V: The socio-economic and political challenges of Climate Change affecting biodiversity.

Chapter VI: The National and State Mission: Tshe Loopholes

Chapter VII: Adaptation and Mitigation Strategies for conservation of biodiversity in Santhal Pargana.

Conclusion
References
Bibliography
Appendices

7. Sources of data and tools for collection of data

There are two sources of data collections:

I. **Primary Data**

The Plant species will be recorded along regions to understand the distribution patterns. Point count surveys will be conducted for faunal species to estimate the population densities. Community interviews with local communities will be held to understand the traditional ecological knowledge and their perception of Climate Change impacts. The focus group interviews will be held with the Forest Officers and Forest Management Authorities. The structured interview schedule will be used for collecting the quantitative data from the participants using Delphi technique. The schedule will be designed after reviewing the existing literature.

II. **Secondary Data**

From National and State Government Organizations

National Wildlife Database and India Biodiversity Portal are some of the national organizations publishing the data on wildlife and biodiversity. The Ministry of Forest Department of State as well as National Organizations also publishes the data.

From municipal authorities

The data of agro-bio ecosystems for district level can be collected from the municipal authorities . the land covered in agriculture, sericulture ,fisheries etc. and the water bodies expanded or shrinked in the area. The map from published and unpublished sources would be studied the changed physiography of the Santhal Pargana.

From Indian Meteorological Department

District-wise data of minimum and maximum mean temperature and rainfall variability data is available for public use by the Indian Meteorological Department.

TerraClimate using Google Earth Engine

Data will be obtained from TerraClimate using Google Earth Engine (GEE); using R. The data will be extracted from the gridded climate data using satellite images. Trend analysis of mean temperature and mean annual precipitation would be done using the TerraClimate in the last decades of the study area.

III. **Tools**

The primary or secondary data collection tools to facilitate the field survey and helps in the analyses of the data for research questions, objectives and hypothesis are:

a. Structured and Semi Structured questionnaire for field survey
b. Checklists
c. Microsoft word and Microsoft excel
d. IBM SPSS for statistical analysis
e. QGIS version 3.10 and R studio for mapping and spatial analysis

8. Analysis of the data

The data analysis in the research process is systematically and structurally organizing statistical and logical techniques to explain, compress and evaluate data. For meaningful insights, analysis of data is significant for the information collected to be of use.

Climate Vulnerability Index: with temperature and precipitation variation as the parameters the climate Vulnerability indices will be produced for the Study Area.

Comparative-descriptive Analysis: the natural and agricultural ecosystem in the study area will be compared with the climate change. The similarities and differences between the groups will be evaluated for causal relations. Furthermore, the socio-economic and political challenges will be identified by descriptive statistics as mean etc. Descriptive Statistics and cross-tabulation analysis will be used to accomplish the study objectives.

Correlation Analysis: the quantitative variables of biodiversity and climate change trends would be measured and described for the strength and direction of the relationship between the quantitative variables. Hypothesis will be tested and scatter plot will be formulated as required.

Multivariate Analysis: For analysis of more than two variables simultaneously, multivariate analysis will be performed as and when required.

9. Significance of the study

Adaptation and Mitigation Strategies are much needed in today's scenario as the dynamic change of climate has been rapidly changing causing widespread biodiversity loss making it a global phenomenon. By geographically dividing the regions and making separate plans would cater to the needs of regio specific issues. With spatial analysis from geographical perspective data can be used for the for the formulation of policies and planning an ensure the sustainable management of natural resources.

10. Relevance to the present day problem

1. Global and regional policy initiatives: International treaties such as the Paris Agreement and the Convention on Biological Diversity 1976 emphasize the significant issues of biodiversity loss due to Climate Change.
2. Adaptation and Resilience Infrastructure: Geographic research aids in specifying regions and species that are most adaptable including those needing immediate intervention, thereby directing efforts to enhance ecosystem resilience and stabilizing.

3. Sustainable Development Goals: The Goal 13 which is Climate Action and Goal 15 which is Life on Land both catering to this particular study are focused on the United Nations Sustainable Development Goals for 2030.
4. Cultural and Socio-Economic Impact: Indigenous tribes and Traditional livelihood communities are affected by the biodiversity loss as their economic sustainability is dependent on natural resources.

11. Contribution to existing knowledge

1. Insights into Climate Biodiversity Interactions: the ecological perspective can be explored through this study as the study focuses on the interactions of climate change particularly the temperature and precipitation variation with the biodiversity loss.
2. Development of Regional Adaptation Strategies: the unique challenges of the specific region can be addressed by geographic analysis. Furthermore the new conservation techniques could be explored catering to the needs of the specific regions.

12. Future work

The predictive models could be refined by developing to better forecast the impacts of Climate Change on biodiversity. The research may also focus on the species specific especially those endangered or having a critical ecological roles as many species are interdependent on each other. Biodiversity and Climate Change facilitated the international collaboration that can foster interdisciplinary research by combining expertise from different disciplines as ecology, climatology, hydrology and other social sciences.

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